Towards Rotordynamic Analysis with COMSOL Multiphysics

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Abstract

Rotordynamical calculations are normally carried out with special purpose software's based on Timoshenko beam elements. Forces and moments from interconnections such as bearings, seals, impellers, magnetic fields and the supporting structure are included as added mass, stiffness and damping coefficients. These coefficients are dependent on the operational speed and the rotor whirling frequencies. Rotors are also subjected to gyroscopic effect which is speed dependent. Hence, rotordynamical analysis has to be carried out for the whole speed range that the rotor will operate within; i.e. analysis of natural frequencies, damping, unbalance and other harmonic responses have to be carried out at several speeds to understand the dynamic behavior of the rotor system. From a practical perspective, it is easy to understand the use of special purpose rotordynamical codes. On the other side, the modeling of the machine has to be carried out twice, once for the rotordynamical performance and once for the structural analysis of the machine. Some structural analysis would also be improved if one combines them with rotordynamical analysis for example seismic and sea load analysis. Rotordynamical analysis would also be improved if one could do a better representation of structure. Some commercial "standard" finite element software's has implemented some rotordynamical models; however they are not fulfilled for rotordynamical analysis. In this presentation, the finite element software COMSOL Multiphysics is used to perform rotordynamical analysis of a rotor and its supporting structure. Implementation of special rotordynamical features and simulation approach has been carried out. This includes all standard rotordynamical analysis as well as the possibility to perform structural analysis at selected speeds and operational points. It is concluded that it is possible to use COMSOL Multiphysics to perform rotordynamical analysis. However, there is no standard environment for rotordynamics, hence the user has to extend the structural model with the rotordynamics effect such as gyroscopic effect and rotordynamical coefficients. By using standard purpose software for rotordynamical analysis, one can take the benefit of using detailed model of structures and rotating component in rotordynamical analysis. The presentation is ended with an outlook of suggestion to further developments on rotordynamics in COMSOL Multiphysics.

Reference

1. Chen, W. J., Gunter, E. J., Introduction to Dynamics of Rotor-Bearing Systems, Victoria, BC, 2007
2. Friswell, M. I., Penny, J. E. T., Garvey, S. D., Lees, A. W., Dynamics of Rotating Machines, New York 2010

Figures used in the abstract

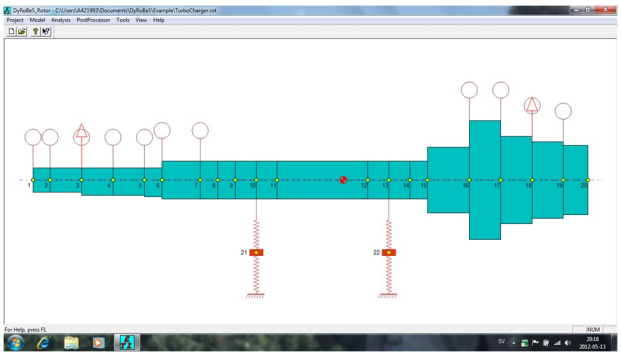

Figure 1: Rotor model in a traditional rotordynamical code.

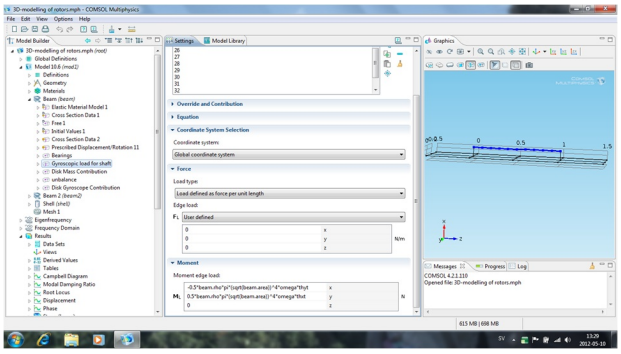

Figure 2: Simple rotor model in COMSOL.

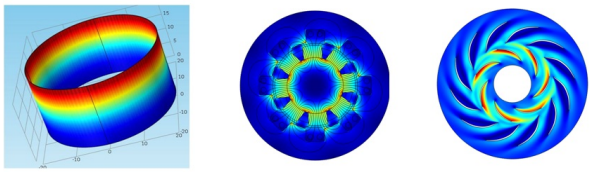

Figure 3: Multiphysical interactions in COMSOL.

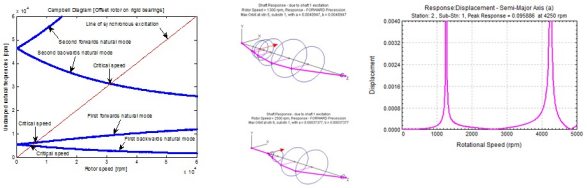

Figure 4: Typical rotordynamical analysis.